ADF&G TECHNICAL DATA REPORT NO. 2
(Limited Distribution)

STATE OF ALASKA
William A. Egan, Governor

1971 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

By:
Philip A. Russell and Michael L. McCurdy

1972

ALASKA DEPARTMENT OF FISH AND GAME
Subport Building, Juneau, Alaska 99801

ADF&G TECHNICAL DATA REPORTS

This series of reports is designed to facilitate prompt reporting of data from studies conducted by the Alaska Department of Fish and Game, especially studies which may be of direct and immediate interest to scientists of other agencies.

The primary purpose of these reports is presentation of data. Description of programs and data collection methods is included only to the extent required for interpretation of the data. Analysis is generally limited to that necessary for clarification of data collection methods and interpretation of the basic data. No attempt is made in these reports to present analysis of the data relative to its ultimate or intended use.

Data presented in these reports is intended to be final, however, some revisions may occasionally be necessary. Minor revision will be made via errata sheets. Major revisions will be made in the form of revised reports.

FORM 02-001B

MEMORANDUM State of Alaska

TO: Mel Seibel, Senior Biometrician
Commercial Fisheries Division
Juneau

DATE : November 22, 1972

FROM: Michael Mc Curdy
Commercial Fisheries
King Salmon

SUBJECT: Errata for the 1971 Naknek River smolt report

Considering the lack of information in the 1971 Naknek River smolt report the only data that needs revising is the following under the RESULTS section:

Pg. 31-Second paragraph, 1st line, change "10,974,144" to "10,864,064".

Pg. 31-Second paragraph, 2nd line, change "300,000" to "200,000."
Pg. 31-Second paragraph, 3rd line, change "8,117,574" to "8,036,148."
Pg. 31-Second paragraph, 4th line, change "2,856,570" to "2,827,916."
Pg. 31-Second paragraph, 5th line, change "10,974,144" to "10,864,064."

The reason for this mixup was that I obtained the outmigration estimate method from the 1968 ADF&G Informational Leaflet No. 138. Here the author used an average percent, computed from past years, that the index scheme took and plugged it in to the method. He should have used that percent which occurred for that year. I used the average.

It was not until Herb Jaenicke came along that I discovered the mistake.

This year I plan to write up the complete analysis scheme in the report for the ADF&G Technical Report.

cc: Bob Paulus, Anchorage

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1971 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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A. KVICHAK RIVER SOCKEYE SALMON SMOLT INDEXING PROGRAM

INTRODUCTION

1971 represents the eighteenth year that an index has been obtained on sockeye salmon smolt (Oncorhynchus nerka) leaving Iliamna Lake and migrating down the Kvichak River. Information obtained from these indices is used to forecast age composition and magnitude of adult returns to the Kvichak River. The data is also used to evaluate smolt production from various levels of adult escapement.

The indices, though showing a good escapement-production relation, have proven to be unreliable as a source of information from which to predict adult sockeye returns to the Kvichak River. Factors affecting indexing are smolt which migrate beneath the ice from lake break-up, irregular river bottom contour, two channels at the operations site, and annual variations in water level, turbidity, and light intensity; evidently a great part of the unreliability also comes from variance in marine survival rates.

The index project has, however, provided information on population dynamics of the Iliamna Lake system sockeye and its continuation is presently necessitated by need of comparative annual data.

A federally funded study, using funds from the Commercial Fisheries Research and Development Act (P.L. 88-309), was initiated in 1965 to improve the index program or obtain a total outmigration estimate. Beginning the fiscal year 1969-70, the federal funding was changed to the Anadromous Fish Act (P.L. 89-304).

METHODS AND PROCEDURES

This year, as in all past years, a standard 4 foot by 4 foot fyke net

was fished in the same location (Figure 1) and at the same depth (3.8 feet). Fyke net fishing began May 23 and ended June 18. Twenty-four hour sampling began on May 23 and ended on June 18. All fishing time lost was due to ice, wind, algae, detritus, and changing water levels.

Photo-Electric Counter Calibrations

The methods of calibration were basically the same as in previous years. To eliminate possible counting variations that can occur when the cod end of the fyke net must be lifted out of the water which allows smolt to "ball up" in the body of the net and be counted as a large mass when the net is again lowered into the water, the body of the photo tunnel was extended and a "valve" incorporated into it so that smolt could pass by the photo-counter or be shunted past it. The photo counters were also equipped with a switch that would allow the photocells to be turned off, facilitating index number readings during heavy migration periods and preventing erroneous counts when the photo tunnel was lifted out of the water to remove the cod end.

Fishing with photo-electric counters began June 11 and terminated June 18. Daily mean conversion ratios of smolt per count ranged from 3.99 to 8.81. The seasonal average was 7.34 with standard deviation $\pm$ 1.93. Photo-counter calibration data is presented in Table 1.

RESULTS

Climatological and Hydrological Data

It has been assumed that environmental factors including physical break-up of the Iliamna ice, water temperature, wind and photo-period, were instrumental in triggering the smolt outmigration. Data on several factors other than photo-period are gathered each year for material from which timing might be predicted and more fully understood.

The 1971 spring break-up came late following a very cold winter. In late May the ice cover was four feet thick at the edge of the ice pack two miles north of Igiugig Village, at that time 95% of the lake was covered with unbroken ice. Ice break-up began in late May following steady downlake winds and a week of rain, the first major flow of ice was observed June 5. Ice flows occurred frequently throughout the season and considerable index fishing time was lost and equipment damaged. Some fishing time was lost when the index fyke nets were being cleaned of algae or being relocated to maintain the standard 3.8 foot fishing depth.

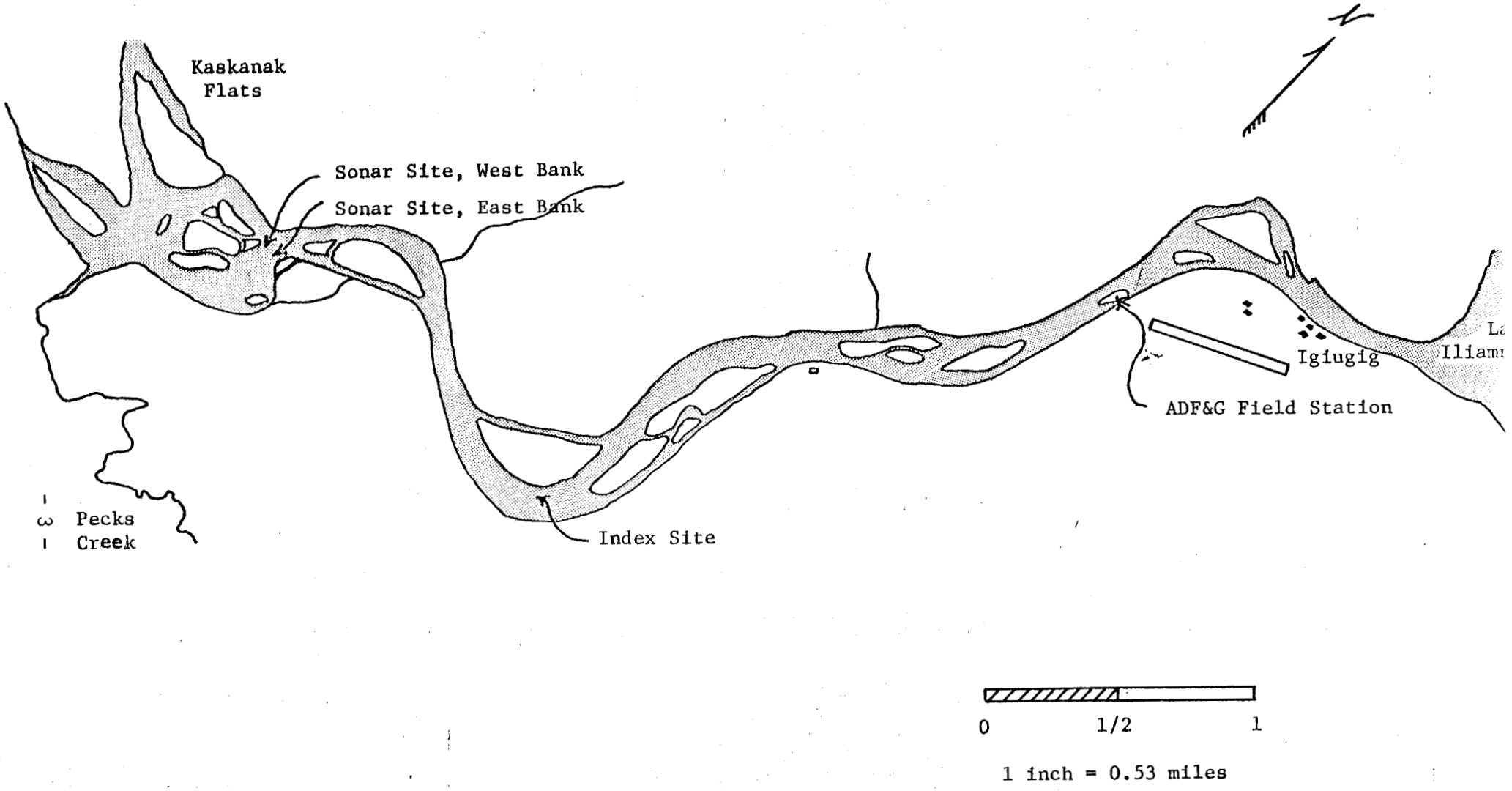


Figure 1. Upper Kvichak River sample sites, 1971

Table 1. Kvichak River sockeye salmon smolt photo-counter calibrations, 1971.

Date	Hour	Sampling time	Weight	Fish per pound	Total fish	Counts	Counts per second	Fish per second	Fish per count	Daily avg. fish/count
6/11	0255	300(?)	23.0	64	1472	111			13.26	
	0335	65.2	11.8	50	590	103	1.58	9.05	5.73	8.81
	0755	60.0	13.9	67	931	125	2.08	15.52	7.45	
	1512	3120.0	20.4	66	1346	317	0.10	0.43	4.25	
	1809	71.6	13.2	65	858	109	1.52	11.98	7.87	
	2300	215.2	13.3	66	878	113	0.53	4.08	7.77	
	2312	134.8	14.1	72	1015	117	0.87	7.53	8.68	7.91
	2345	301.6	11.9	67	797	103	0.34	2.64	7.74	
6/12	0006	448.5	12.3	74	910	94	0.21	2.03	9.68	
	0103	571.8	13.5	70	945	105	0.18	1.65	9.00	
	0132	653.1	7.2	81	583	53	0.08	0.89	8.29	
	2208	305.0	10.7	76	813	112	0.37	2.67	7.26	
	2230	103.5	12.5	71	888	113	1.09	8.58	7.85	
	2242	343.5	11.6	72	835	115	0.37	2.43	7.26	
	2334	459.0	11.8	76	897	111	0.24	1.98	8.08	
	2351	449.6	14.7	73	1073	125	0.28	2.39	8.58	8.62
6/13	0012	228.0	14.7	79	1161	111	0.49	5.09	10.46	
	0026	268.5	11.9	80	952	109	0.41	3.55	8.73	
	0043	1058.3	8.9	79	703	79	0.07	0.66	9.37	
	1103	76.6	14.3	75	1073	107	1.40	14.01	10.02	
	1208	171.9	10.8	78	842	105	0.61	4.90	8.02	
	1345	240.2	11.3	61	689	113	0.47	2.87	6.10	
	1425	120.6	11.3	67	757	101	0.84	6.31	7.35	7.74
	2308	3120.0	14.3	79	1130	119	0.04	0.36	9.49	
6/14	2314	2760.0			114	27	0.01	0.04	4.24	
6/15	0004	3240.0			224	43	0.01	0.07	5.21	4.73

Table 1. Kvichak River sockeye salmon smolt photo-counter calibrations, 1971. (continued)

Date	Hour	Sampling time	Weight	Fish per pound	Total fish	Counts	Counts per second	Fish per second	Fish per count	Daily avg. fish/count
6/15	1313	2820.0	4.2	40	168	34	0.01	0.06	4.94	
	1400	3600.0	9.0	46	414	85	0.02	0.12	4.87	
	2209	1455.0	10.0	53	530	78	0.05	0.36	6.79	
	2319	793.1	10.0	71	710	106	0.13	0.90	6.98	6.53
6/16	0140	753.0	11.3	80	904	108	0.20	1.69	8.37	
	0201	232.6	11.5	71	817	101	0.44	2.53	8.08	
	0212	600.0	2.1	73	153	16	0.03	0.26	9.58	
	0504	783.1	9.7	73	708	138	0.18	0.90	5.13	
	0550	401.1	7.7	61	470	99	0.25	1.17	4.74	
	0903	45.0	9.2	58	534	134	2.98	11.87	3.99	3.99
	1219	120.0	3.8	56	213	39	0.33	1.78	5.46	
	1935	102.0	12.2	52	634	112	0.11	0.62	5.66	5.76
	2310	1200.2	10.5	68	714	116	0.10	0.60	6.16	
6/17	0110	3000.0	7.1	68	483	79	0.03	0.16	6.11	6.11
6/18	2300	3600.0	3.8	68	258	41	0.01	0.07	6.30	6.30

Weather data was collected using the same procedures as 1970. The water depth gauge consisted of a metal stack in the river from which relative water depths were measured each day.

Water temperatures during the 1971 season ranged from 34° F to 39° F, the major peak of the outmigration occurred when the average water temperature was 37° F (June 11). The date of peak migration was ten days later than any previously recorded. The 1971 season's weather data is presented in Table 2.

Index Net Catch

The season's expanded twenty-four hour index catch was 1,927,984 smolt. Approximately 81% of the smolt migration occurred during the three day period beginning June 10-11 and ending June 12-13. The smolt run peaked within hours after its start on June 10th and was reduced to low levels by June 18.

Index hour catches (2200-0100) accounted for only 11% of the total index and necessitated indexing during all hours, as weather and ice conditions permitted. Figure 2 illustrates the unusual outmigration pattern of 1971, with groups of smolt migrating at various hours throughout the day rather than migrating primarily during index hours.

The total twenty-four hour expanded catch is shown in Table 3. Methodology was the same as described in Alaska Department of Fish and Game Informational Leaflet No. 83, the one exception being where large blocks of fishing time were missing. When this occurred the available catch per period was expanded by the hours of missing data and the average percentage of catch missed, as derived from total unestimated hours for the season; this method was used because peak runs occurred during different time periods throughout the season.

Length and Weight of Smolt by Age Group

Twenty-four samples were taken throughout the season to determine length distribution, four of these were also used to determine weight distribution. Using scale analysis, the age separation point was found to be approximately 101 millimeters. One hundred and sixty-one scales were aged during the season with most of the samples bracketing the separation length. By weighting daily index numbers with appropriate length-frequency data it is estimated that the 1971 smolt index catch consisted of 1,803,040 (93.5%)

Table 2. Weather observations, Kvichak River, May 18-June 20, 1971.

Date	Sky 0900	Sky 2000	Wind Dir.-Vel. 0900	Wind Dir.-Vel. 2000	Air temp. °F Max-Min.	Water temp. °F 0900	Water temp. °F 2000	Water gauge (ft)	Turbidity 0900
5/17									
18	3	3							
19	1	2	25NE						
20	4	4	40NE						
21	4		0						
22	4		15SW		64(?)-31				
23	1		10NE						
24	3	4	5NE			35.5		0.40	A
25	4	4	20NE	15NE	40-34	34			B
26	4	3	10NE	3NE	49-36	37.5	35		A
27	4	4	16NE	13NE	44-30	37.5	35		A
28	3	4	20NE	10SW	52-34		36		B
29	4	4	20NE	15NE	51-32	36	35		A
30	4	4	20NE	10NE	54-38	37.5	35		A
31	4		25NE	30NE		36	35		C
6/ 1	4	3	10NE	25SW	45-36	36	37	0.45	B
2	4	3	10SE	0		36		0.46	B
3	3	4	10NE	10NE	41-39	36	37.5	0.56	A
4	4	4	15NE	20NE	46-38	37	36	0.63	B
5	2	1	20NE	5NE	60-38	36	37	0.67	B
6	3	4	20NE	20NE	54-36	36	34	0.71	B
7	3	4	20NE	20NE		36	35	0.81	C
8	4	4	10NE	10NE	50-38	36	36	0.74	B
9	3	4	15NE	5NE	52-38	36	35		C
10	4	4	10NE	0	67-38	36	37	0.97	C
11	4	4	15SW	10SW	67-36	38	37		A
12	4	2	10SW	5SW	65-40	36	38	0.98	B
13	2	1	15SW	15SW	65-38	37	37	0.98	B
14	4	4	5SW	5NE	60-38	37	38	1.30	A
15	4	4	5NE	10SW	53-38	36	39	1.40	A
16	4		10NE			38		1.58	D
17	4	4	0	5SW		36		1.50	C
18	4		5SW			37.5			A
19	4		10SW			38		1.65	A
20	2								

Table 2. Weather observations, Kvichak River, May 18-June 20, 1971. (continued)

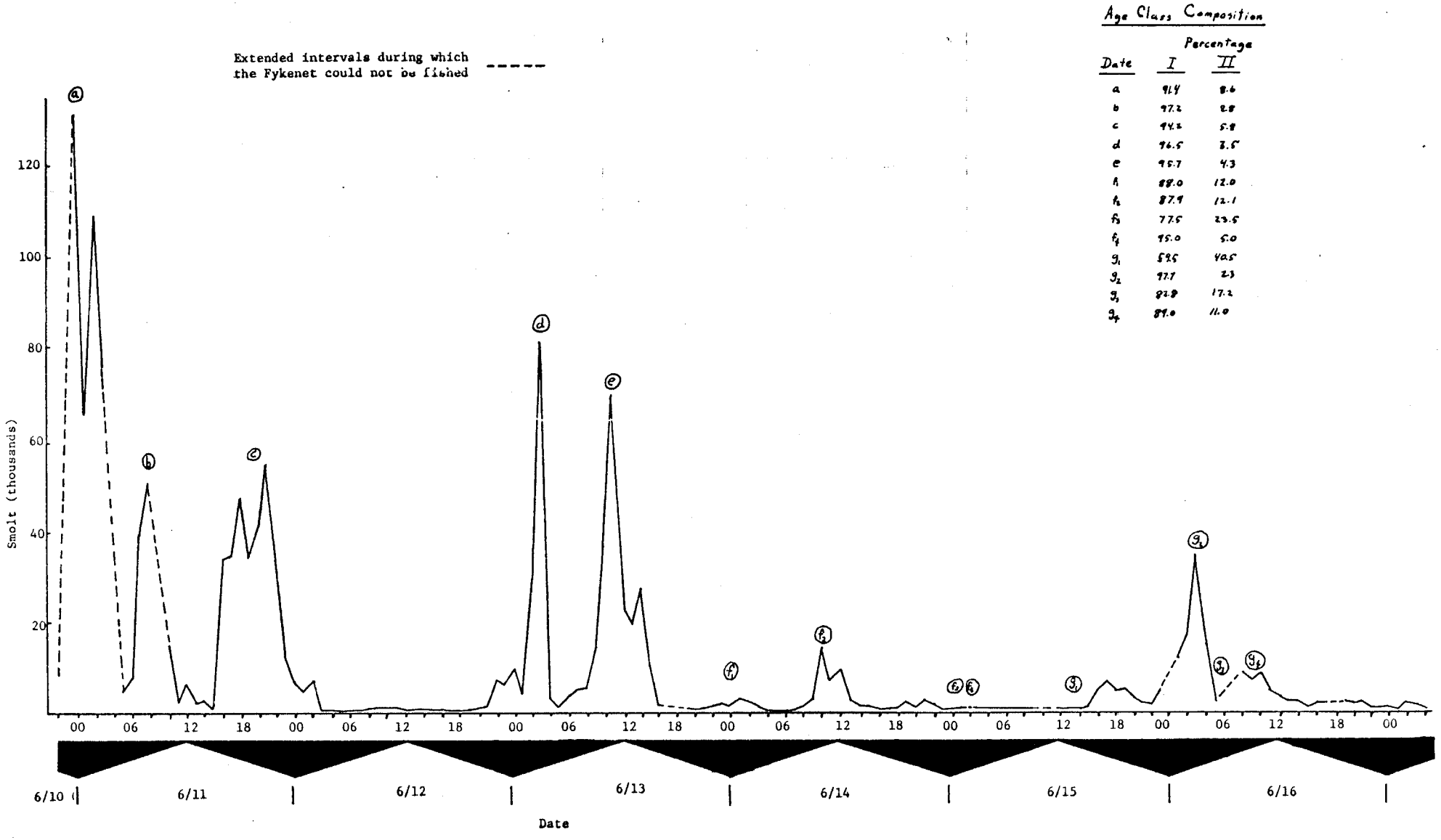
Codings:

Sky

1 - Clear sky, cloud covering not more than 1/10.
2 - Cloud covering not more than 1/2 sky.
3 - Cloud covering more than 1/2 sky.
4 - Complete overcast.
5 - Fog or thick haze.

Turbidity

A - Clear
B - Partly Cloudy
C - Cloudy
D - Debris



Age Class Composition

Date	Percentage I	Percentage II
a	91.4	8.6
b	97.2	2.8
c	94.2	5.8
d	96.5	3.5
e	95.7	4.3
f_1	88.0	12.0
f_2	87.9	12.1
f_3	77.5	23.5
f_4	95.0	5.0
g_1	59.5	40.5
g_2	97.7	2.3
g_3	82.8	17.2
g_4	89.0	11.0

Figure 2. Daily fyke net catches of sockeye smolt by hour during the peak run, Kvichak River, 1971.

Table 3. Kvichak River daily salmon smolt index catches by date, 1971.

Time	5/23-6/7	6/7-6/8	6/8-7/9	6/9-6/10	6/10-6/11	6/11-6/12	6/12-6/13	6/13-6/14	6/14-6/15	6/15-6/16
1200		(0)	(0)	0		7,352	371	23,318	9,120	433
1300		(0)	(0)	0		3,188	607	19,023	2,785	414
1400		(0)	(0)	(0)		3,698	51	27,835	1,443	412
1500		(0)	(0)	0		1,548	68	10,635	1,116	1,789
1600		(0)	(0)	(0)	(304,901)	34,038	202	1,130	384	4,864
1700		(0)	(0)	(0)		35,454	69	(604)	772	6,737
1800		(0)	13	0		47,239	344	(604)	629	4,259
1900		(0)	0	1		31,983	588	(604)	2,265	4,883
2000		(0)	5	(0)		36,851	1,428	77	864	3,221
2100		(0)	20	(0)		47,478	1,092	526	2,516	2,401
Sub-total		0	38	1	304,901	248,829	4,819	84,356	21,895	29,413
2200		0	3	110	8,514	33,123	7,968	1,101	1,782	2,022
2300		1	1	175	(69,562)	13,703	7,696	1,298	148	5,448
2400		5	6	68	128,610	7,945	9,852	837	249	(8,837)
Sub-total		6	10	353	205,686	54,771	25,446	3,236	2,159	16,307
0100		57	5	295	65,277	5,347	4,431	3,166	519	12,226
0200		25	7	(178)	108,746	7,859	29,557	2,368	(356)	17,943
0300		0	0	(178)	76,190	0	80,788	827	192	35,463
0400		347	90	61	(40,739)	26	3,106	0	0	15,785
0500		6	0	141	5,288	9	667	170	0	2,291
0600		(0)	0	0	8,148	17	4,536	248	5	(5,733)
0700		(0)	(0)	0	38,956	17	5,552	271	0	(5,733)
0800		(0)	0	(0)	50,481	66	5,824	859	0	9,174
0900		0	0	(0)	(33,138)	171	14,863	3,878	(217)	7,194
1000		0	0	(0)	15,795	274	36,324	14,869	(217)	8,532
1100		0	0	(0)	2,458	643	69,518	7,190	(217)	5,406
Sub-total		435	102	853	445,216	14,429	255,166	33,856	1,723	25,480
Daily	389	441	150	1,207	955,803	318,029	285,481	121,448	25,777	171,300
Acum	389	830	980	2,187	957,490	1,276,019	1,561,500	1,682,948	1,708,735	1,879,925
% Age I	83.8	68.7	47.6	72.1	96.8	90.0	96.2	87.9	85.8	84.6
No. Age I	326	307	71	870	925,218	286,226	274,633	106,753	22,117	144,835
% Age II	16.2	30.3	52.4	27.9	3.2	10.0	3.8	12.1	14.2	15.4
No. Age II	63	134	79	337	30,585	31,803	10,848	14,695	3,660	26,365

Table 3. Kvichak River daily sockeye salmon smolt index catches by date, 1971 (cont.).

Time	6/16-6/17	6/17-6/18	6/18-6/19	6/19-6/20	Unexpanded Data Total	Unexpanded Data Avg./Hr.	Unexpanded Data Percent	Total
1200	3,972		0	0	44,566	4,952	3.2	44,566
1300	2,881		0	0	28,898	3,211	2.1	28,898
1400	2,854		0	0	36,893	4,485	2.9	36,293
1500	1,062		0	0	16,218	1,802	1.2	16,218
1600	4,800		0	0	43,018	5,377	3.5	43,018
1700			0	81	43,431	6,204	4.0	46,116
1800	(2,622)		0	0	52,484	6,361	4.2	55,710
1900	2,843	(162)	132	0	42,695	4,744	3.1	43,299
2000	2,399		(70)	0	44,845	5,606	3.6	44,915
2100	2,795		7	52	56,888	6,321	4.1	56,888
Sub-total	26,228		209	133				720,822 1/
2200	1,058		382	0	56,043	4,670	3.0	56,043
2300	1,074		258	0	29,802	2,709	1.7	98,364
2400	1,203		321	8	149,084	12,424	8.0	157,921
Sub-total	3,335		961	8				212,328
0100	580		60		91,963	8,360	5.4	91,963
0200	2,223		1		68,729	18,748	12.1	169,263
0300	1,842		1		195,313	19,531	12.6	195,491
0400	1,001	55	19		20,490	1,834	1.2	61,229
0500		0	0		8,522	779	0.5	8,572
0600		0	0		12,954	1,439	0.9	18,687
0700		0	0		44,796	5,600	3.6	50,529
0800	(11,241)	0	0		66,404	7,378	4.8	66,404
0900		0	0		26,106	3,263	2.1	59,461
1000		0	0		75,794	8,422	5.4	76,011
1100		0	0		85,215	10,652	6.9	85,432
Sub-total	16,887	55	81					894,283 2/
Daily	46,450	217	1,251	141			100.0	1,927,984
Acum	1,926,375	1,926,592	1,927,843	1,927,984				
% Age I	86.5	90.3	94.1	93.5				93.5
No. Age I	40,179	196	1,177	132				1,803,040
% Age II	13.5	9.7	5.9	6.5				6.5
No. Age II	6,271	21	74	9				124,944

1/ Includes 304,901 smolt that could not be apportioned to any one time period.
2/ Includes 11,241 smolt estimate that could not be apportioned to any one time period.
Note: Figures in parenthesis are interpolated estimates for periods when fishing was not conducted.

Age I smolt and 124,944 (6.5%) Age II smolt. Age I smolt averaged 89.9 millimeters in length and 5.8 grams in weight while Age II smolt averaged 111.0 millimeters and 11.1 grams. The weight/length relationship of Age I and Age II smolt respectively for 1971 is:

$$\text{weight}_I = \text{length}_I\ (.0683) - .3213$$

$$r_I = 0.88 \qquad N = 190$$

and

$$\text{weight}_{II} = \text{length}_{II}\ (.2802) - 20.047$$

$$r_{II} = 0.90 \qquad N = 23$$

where:

weight is measured in grams
length is measured in millimeters

Figure 3 shows the length frequency distribution of 2,515 smolt taken throughout the 1971 season.

HISTORICAL DATA

A total index of 310,267 smolt was obtained for brood year 1968; Age I smolt made up 59.7% (185,356) of the total and Age II made up 40.3% (124,911). The index was considerably lower than what would have been expected from brood year escapement. Historical escapements and relative smolt productions by brood year are presented in Table 4.

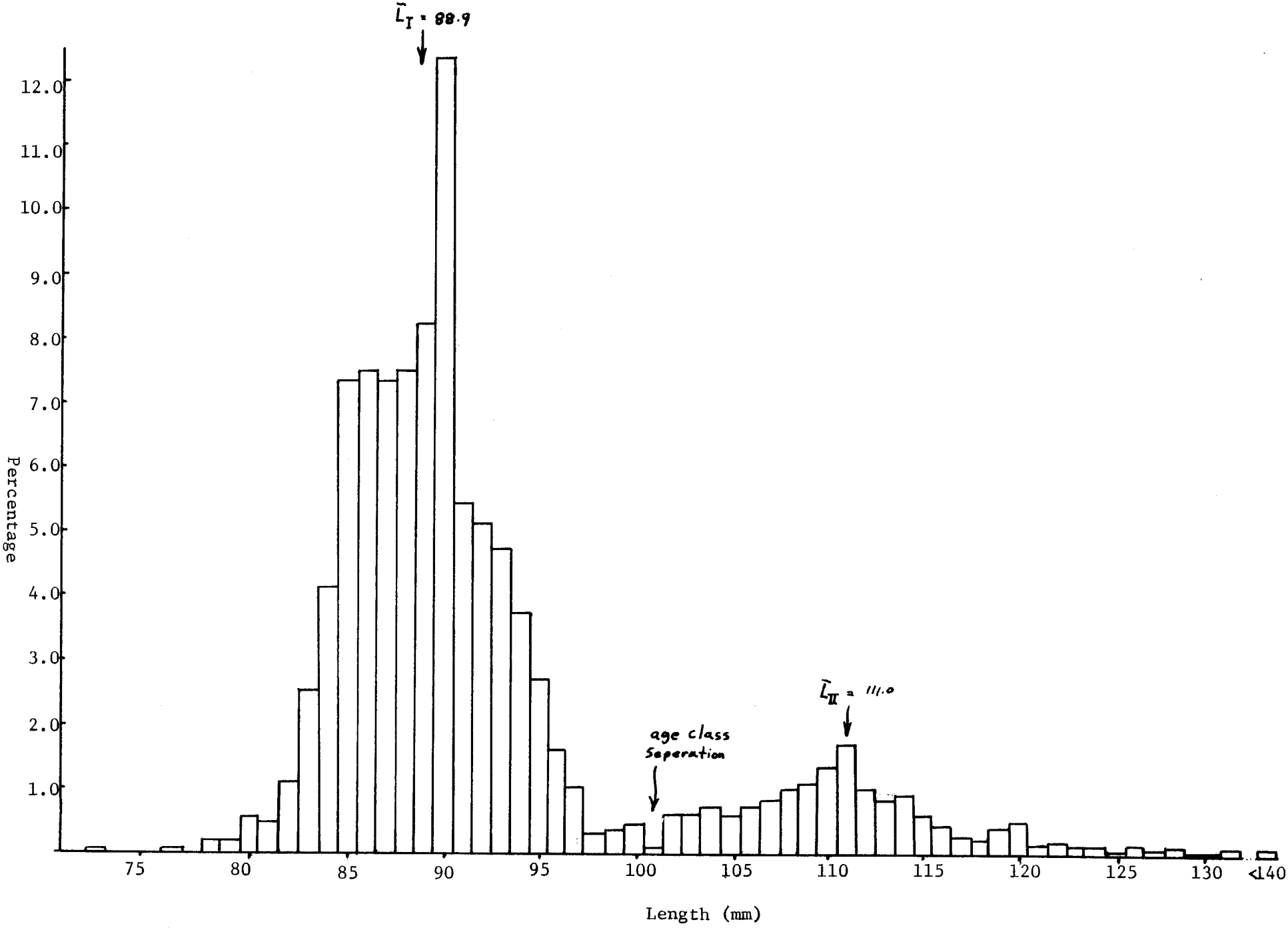


Figure 3. Length frequency summary of sockeye smolt, index site, Kvichak River, 1971

Table 4. Smolt production from respective escapement, Kvichak River, 1952-1970 (brood year).

Brood Year	Escapement	Smolt production (index) Age I	Age II	Total
1952	5,970,000		241,780	
1953	321,000	18,198	47,373	65,571
1954	241,000	30,287	8,654	38,941
1955	250,546	22,253	66,679	88,932
1956	9,443,318	3,267,274	2,777,960	6,045,234
1957	2,842,810	85,916	552,603	638,519
1958	534,785	61,400	10,126	71,526
1959	680,000	26,038	72,180	98,218
1960	14,630,000	1,130,820	4,116,093	5,246,913
1961	3,705,849	113,338	1,603,464	1,716,802
1962	2,580,884	458,122	1,748,178	2,206,300
1963	338,760	64,377	23,377	87,754
1964	957,120	252,384	222,528	474,912
1965	24,325,426	2,866,214	5,475,362	8,341,576
1966	3,775,184	648,321	541,017	1,189,338
1967	3,216,208	594,327	298,282	892,609
1968	2,557,440	185,356	124,911	310,267
1969	8,394,204	1,802,645		
1970	13,935,306			

B. TOTAL OUTMIGRATION ESTIMATE

INTRODUCTION

In 1970 the first sonar smolt counter produced by Bendix Electrodynamics Division and engineered by Mr. Al Menin was placed in the Kvichak River. The operation of the equipment in the field demonstrated its smolt detecting capability. In 1971 a refined smolt counter was placed into operation on the Kvichak along with the 1970 model.

The use of sonar type smolt counters is anticipated to allow total smolt outmigration estimates to be made, even under adverse conditions such as under ice, which will be more accurate than the present index method.

METHODS AND PROCEDURES

Sonar Array Characteristics and Construction

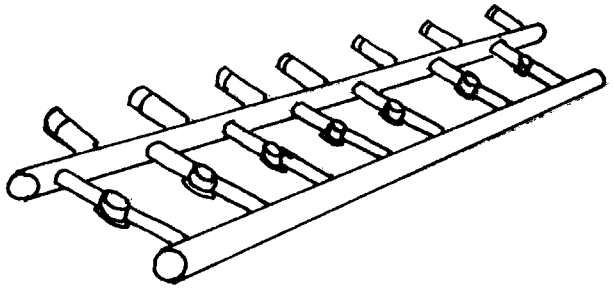
The 1971 arrays were basically the same as the 1970 models with modifications made to place the transducers closer to the bottom (Figure 4). Each array held fourteen transducers (seven upward looking and seven downstream looking). Experimentation with the downstream transducers gave an optimum angle with the river bottom of 18^{o} (the angle 13^{o} on the 1970 arrays), the transducers have a 19^{o} beam width. Observation of sonar returns of an oscilliscope indicated a gradual leveling of the area downstream from the arrays during the season.

Smolt Sonar Characteristics

The 1971 smolt sonar electronics package is basically the same as the 1970 models. The following modifications were incorporated into the 1971 model.

1. Transmit pulse-width was reduced from 150 micro-seconds to 120 micro-seconds.

2. The electronics package had improved sensitivity to lower the count threshold.



Isometric of Assembled Array

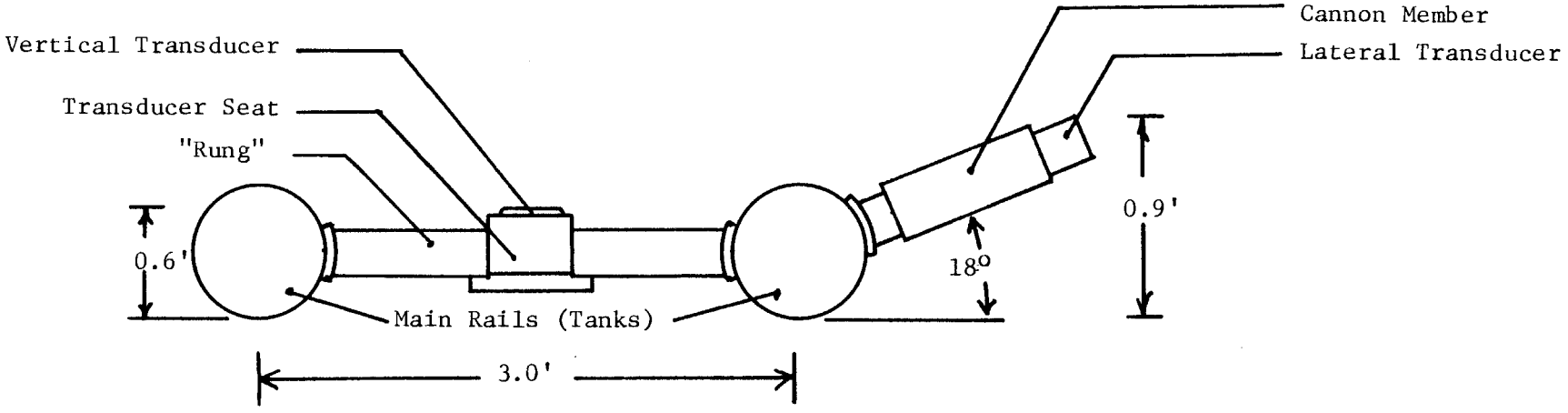


Figure 4. Details of Bendix smolt sonar transducer array, 1971 model.

3. An electronic thermistor circuit with an external probe and panel meter was added to the system to allow continuous monitoring of the water temperature.

4. Modifications were made to allow up to four transducers to be disconnected from the electronics package without influencing the system.

5. Each array was equipped with a separate depth control so that the arrays could be utilized effectively in different depths of water.

6. In the 1971 model the downstream transducers counted only in the bottom half of the river regardless of depth setting, automatic compensation was also made for any beam overlap as the depth setting was readjusted.

7. A new printer and associated electronics was installed which allowed printing of upper and lower banks of transducers for both arrays; corresponding counters were also added.

8. External test points were added to allow circuit monitoring and testing without opening the electronics package.

9. The depth indicator on the 1971 model gave the distance from the river bottom to the range of the sonar beam (the 1970 model gives it from the transducer face).

Site Selection

The 1971 sonar site was located four miles downstream from the ADF&G field station (Figure 1) with the 1971 sonar smolt system being fished off of the east bank and the 1970 system off the west bank. The site was chosen because the river at that location had a relatively smooth, even bottom and is one of the few locations where the river is almost confined to one channel. Tents were placed on both sides of the river to provide shelter for the electronics packages and crew. Figure 5 is a velocity profile of the river between the two sites and gives the positions of the sonar arrays, actual calibrations are presented in Table 5.

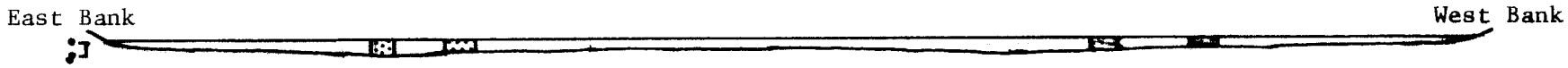


Figure 5 (a). Profile of the Kvichak River (Depth to Width ratio of 1:1), Sonar Site, 1971.

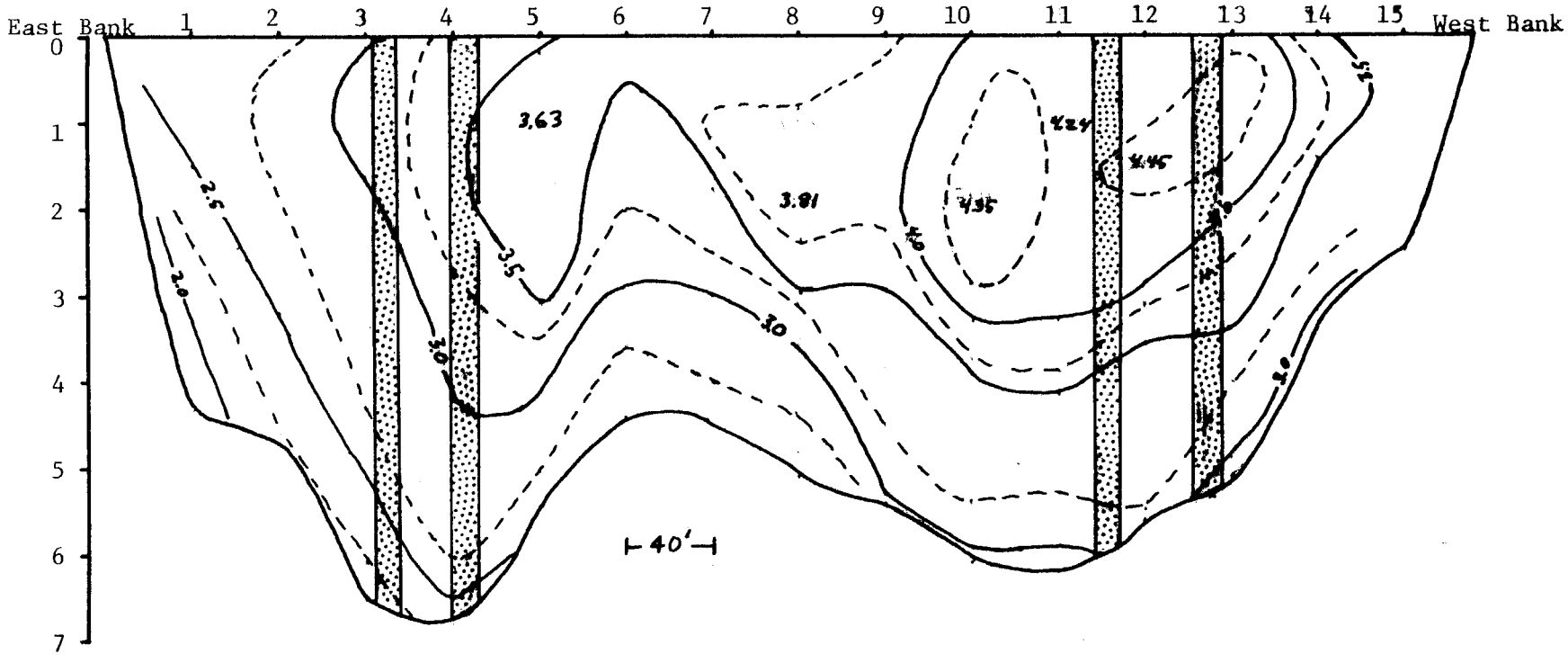


Figure 5. Velocity Profile of the Kvichak River (Depth to Width Ratio 40:1), Sonar Site, 10 June 1971.

Velocity Interval, 0.5 feet per second
Velocity Interval, 0.25 feet per second
Area with Sonar Coverage

Table 5. Velocity profile data in feet per second, sonar site, Kvichak River, 10 June, 1971.

Depth	STATION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Surface (0.3')	2.69	2.72	2.97	3.26	3.47	3.55	3.55	3.55	3.81	4.00	4.24	4.24	4.24	3.55	--
1'	2.61	2.84	3.11	3.32	3.63	3.47	3.79	3.79	3.72	4.24	4.24	4.24	4.35	3.79	(2.5')
2'	2.41	2.67	2.97	3.47	3.47	3.25	3.46	3.81	3.81	4.35	4.24	4.45	4.01	3.34	
3'	2.10	2.52	2.97	3.18	3.25	2.90	3.02	3.55	3.47	4.24	4.24	3.79	3.93	(3.3')	
4'	(4.3')	(4.7')	2.84	3.18	3.06	(4.4')	(4.5')	2.67	3.39	3.42	3.55	3.39	3.25		
5'			2.52	2.87	(5.4')			(5.1')	(5.4')	3.36	3.12	(5.6')	(5.1')		
6'			(6.5')	(6.7')						(6.1')	(6.2')				

Note: 1. Bottom depth in parenthesis, e.g. (6.7').
2. Stations 40' apart starting from the East Bank Sonar Site.

Sonar Calibration

Sonar system calibrations in 1971 were conducted using fyke nets behind the sonar arrays as in 1970. Calibrations were first made for the 1971 model and later in the season on the 1970 model. It was noted that winds over 40 m.p.h. were sufficient to entrap enough air into the river and cause false counts. During ice flows it was also observed that fish could be identified and counted as they swam slightly below the ice level; however, this still means that the instruments must be closely monitored and adjusted when ice is flowing to obtain good population estimates. Using smolt counter design specifications only calibrations which had between 5 and 20 counts/fish were considered valid for data analysis; it is assumed that avoidance, unevenly distributed smolt schools, and inconsistent fish movements probably produce counts which are out of range. The calibration fyke net also had to be fished far enough behind the array so as to be out of the sonar beam. The net covered approximately 9/11ths of the array's acoustic coverage.

A good correlation (0.718) was observed between sonar counts and fyke net samples catches (Figure 6). The actual relation corrected for sampling area disparity, is very close to that of the design parameters. The following formulas give the observed fish to count relation, where F = fish and C = counts:

Theoretical Sonar System parameters

$$F_{1000} = 1.000 \times 10^{-2} (C)$$

Observed Fish per Count

$$F_{1000} = (8.400 \times 10^{-3} (C)) - (2.69 \times 10^{-1})$$

Corrected for sampling net area disparity

$$F_{1000} = (1.027 \times 10^{-2} (C)) - (3.29 \times 10^{-1})$$

Figure 7 illustrates the similarity between sonar counts per hour and sample fyke net fish per hour during the major part of the run.

Comparison of passage rates between the east bank offshore and inshore arrays display a timing consistency with some variation in quantity (Figure 8).

During the season smolt were observed to move vertically relative to daylight--at night close to the surface, during sunrise and sunset near the bottom and midway during the day. No significant difference was noted between the number of out of range counts during day and night indicating that net avoidance whether it is not significant or occurs at the same level regardless of light

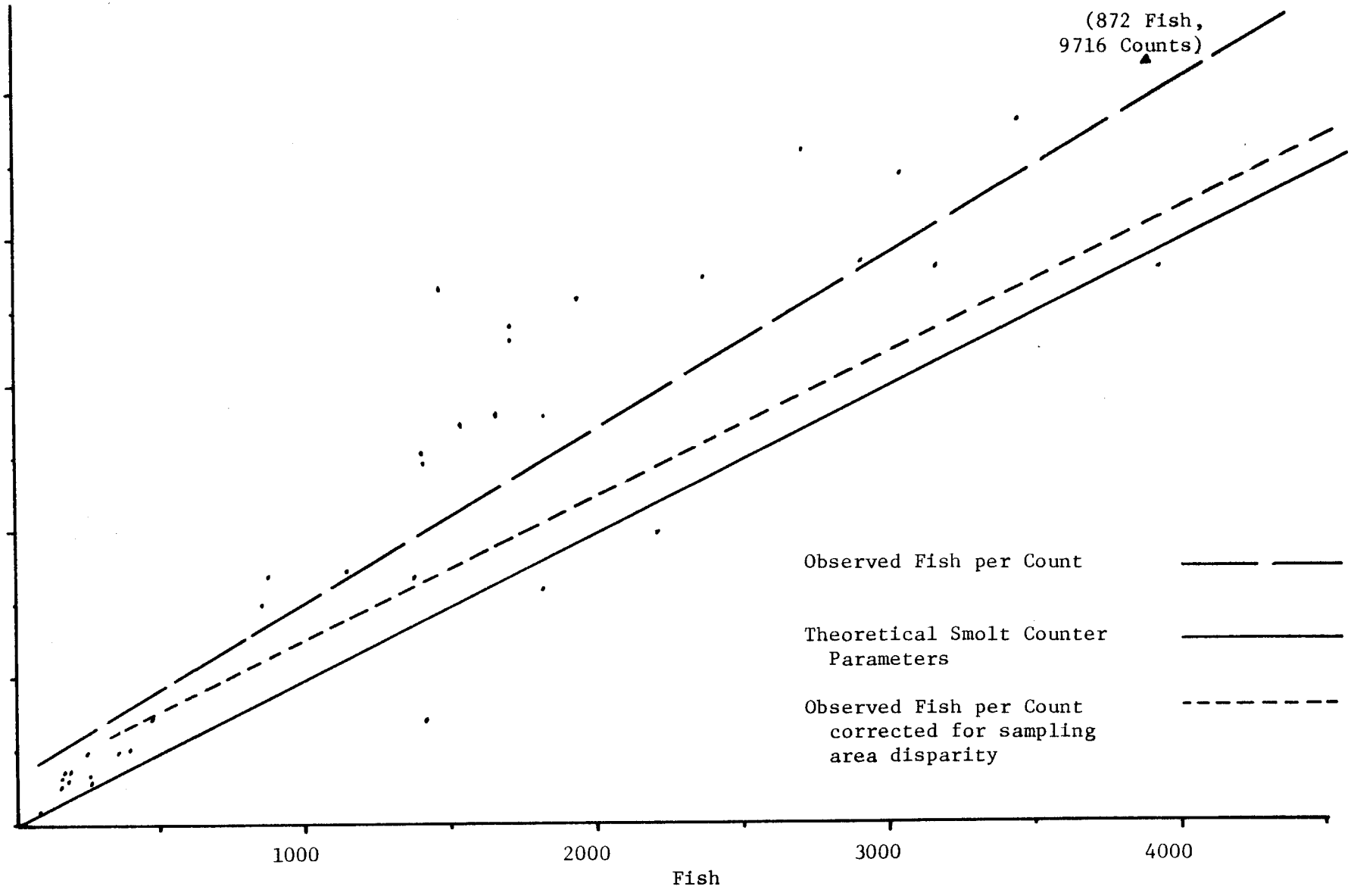


Figure 6. East Bank Sonar Calibrations, Fish per count, Kvichak River, 1971.

Fig. 7. Comparison between East bank offshore sonar array and sampling fyke net hourly passage rates, Kvichak River, 1971.

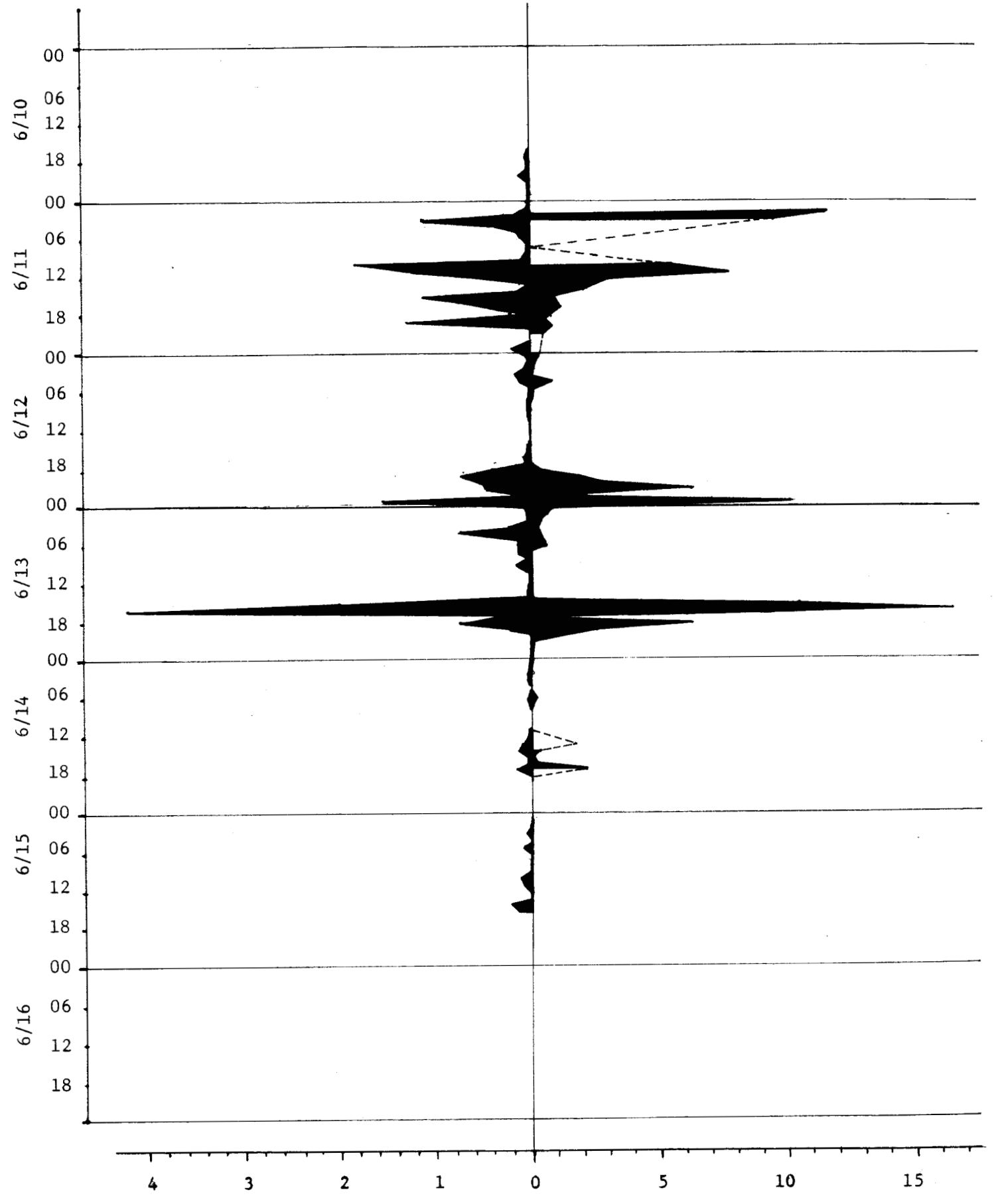
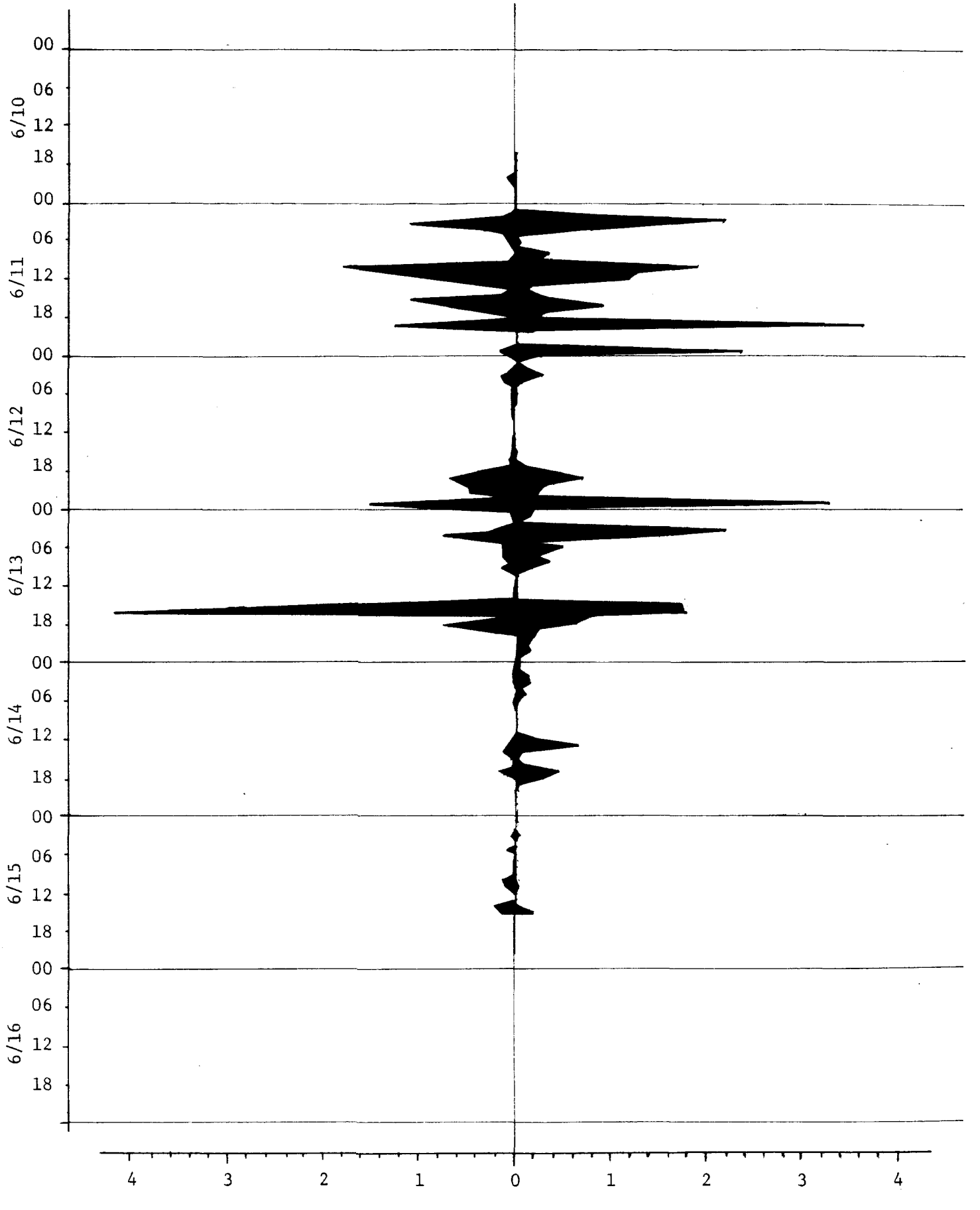


Fig. 8. Comparison between East bank offshore and inshore sonar arrays by hourly passage rates, Kvichak, 1971.



conditions has little effect on inducing count variance.

Late in the season it was discovered that the sonar counter on the west bank was not counting at the designed level thus producing low counts. Fishing ended before sufficient calibrations could be obtained for direct smolt passage routes but the tape data shows there was little similarity between the east and west bank run (Figure 9); a better relation was observed between the west bank counts per hour and the index site fish/hour (Figure 10).

A comparison of length-frequency distributions between the east bank and the index for similar sampling times shows a high degree of similarity (Figures 11 and 12).

Fig. 9. Comparison between East bank and West bank sonar site by hourly passage rates, Kvichak River, 1971.

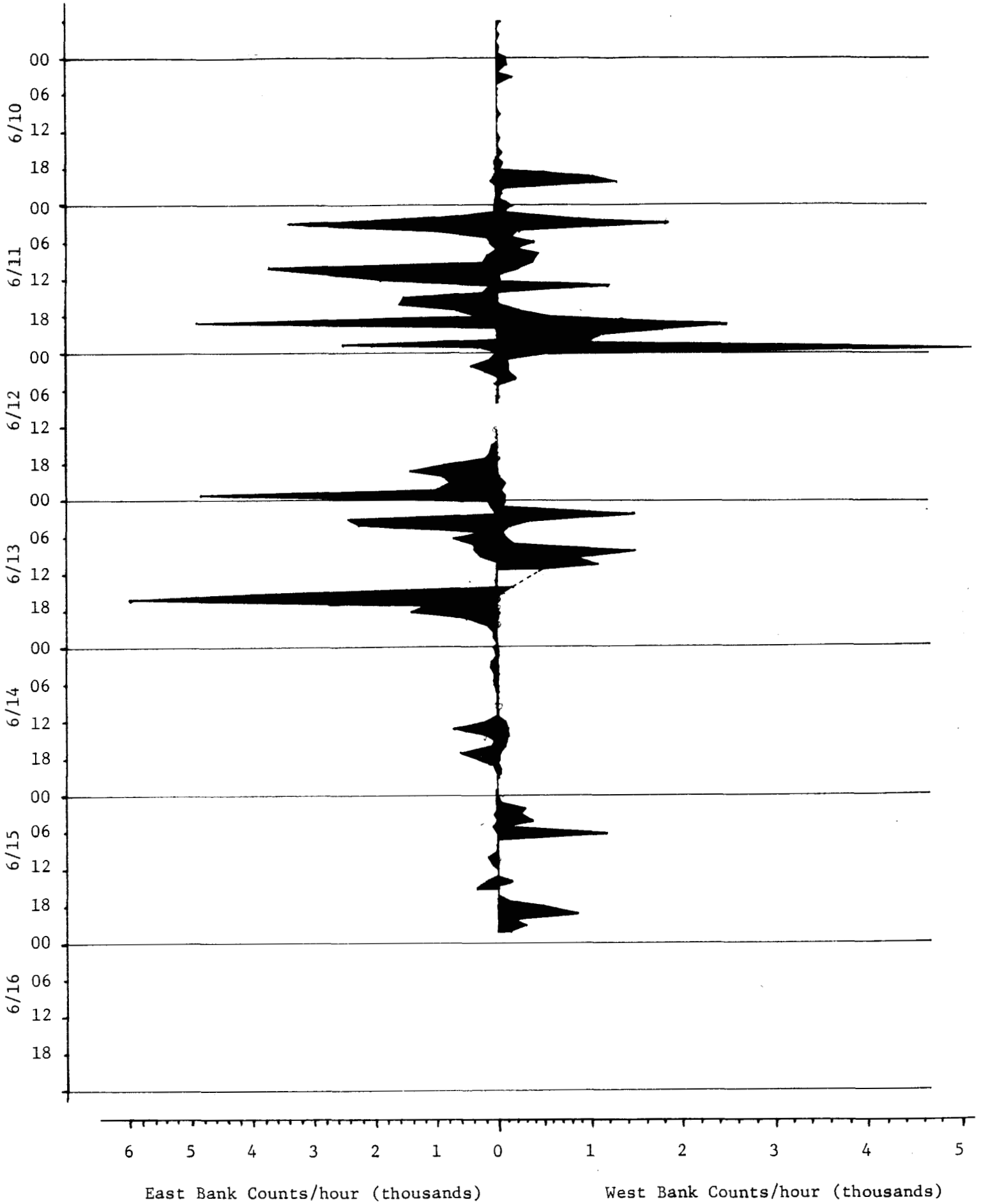
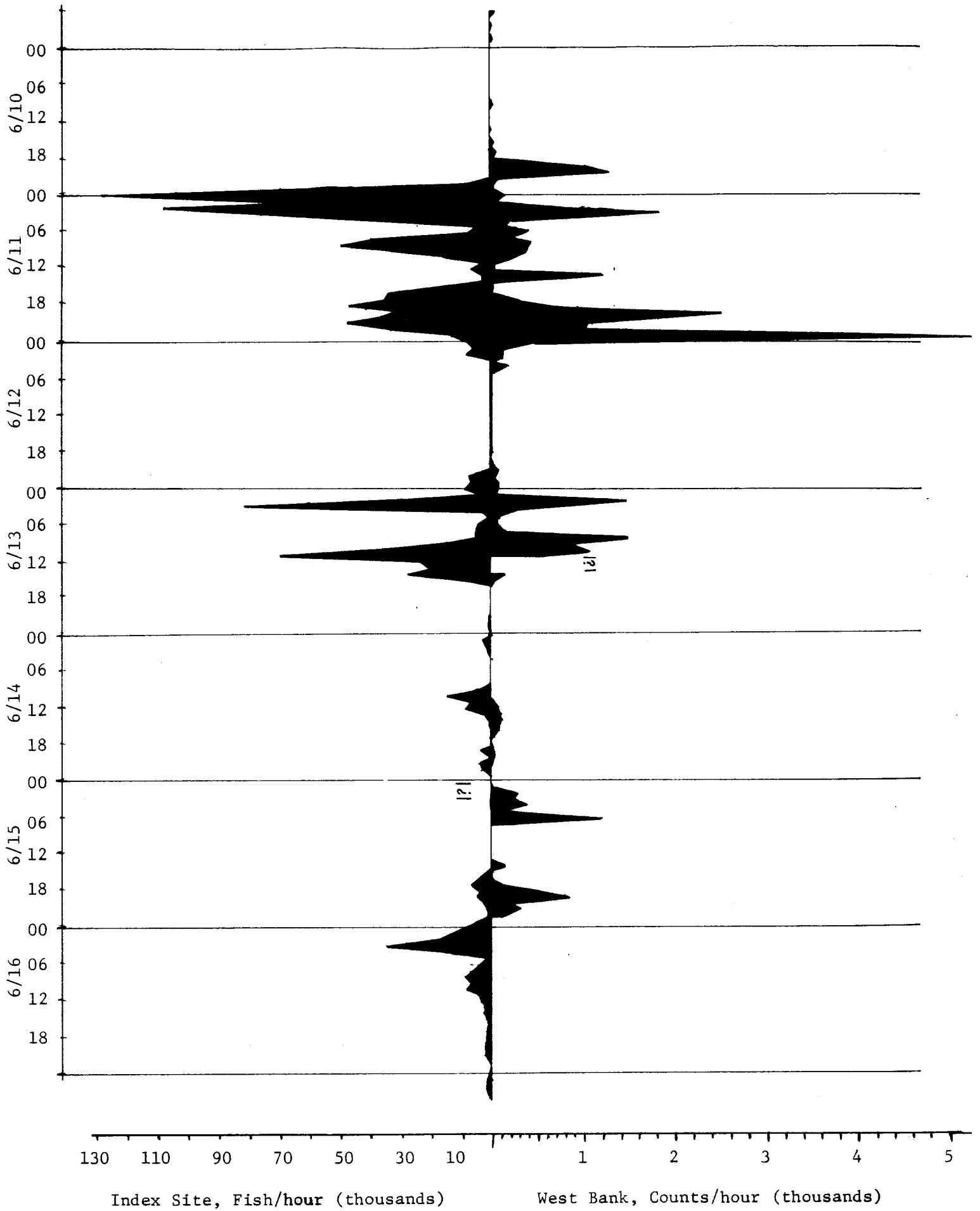


Fig. 10. Comparison between Index site, fish/hour, and the west bank sonar site, counts/hour, Kvichak River, 1971.



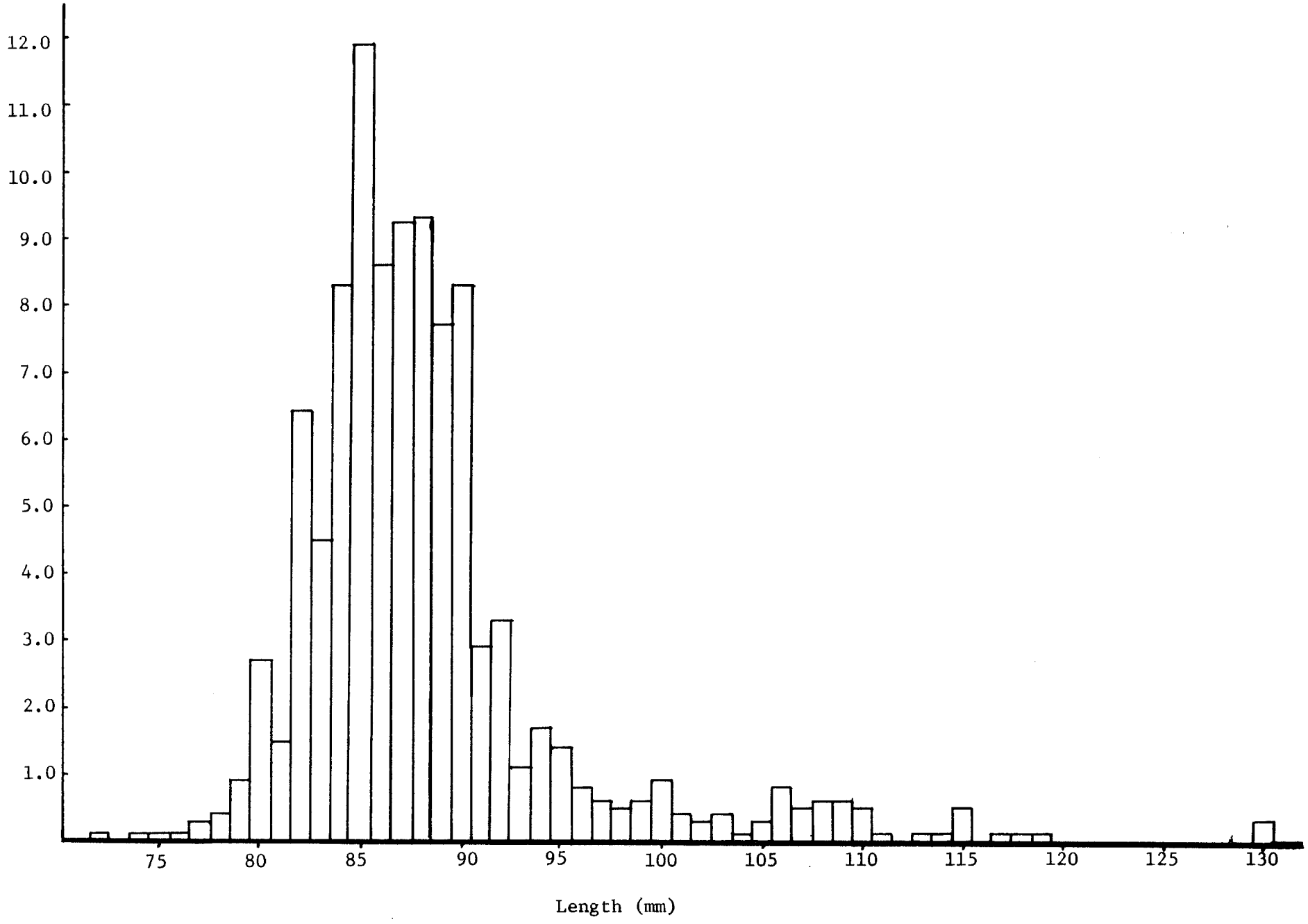


Figure 11. Length frequency summary of sockeye smolt, east bank sonar site, Kvichak River, June 11-13, 1971

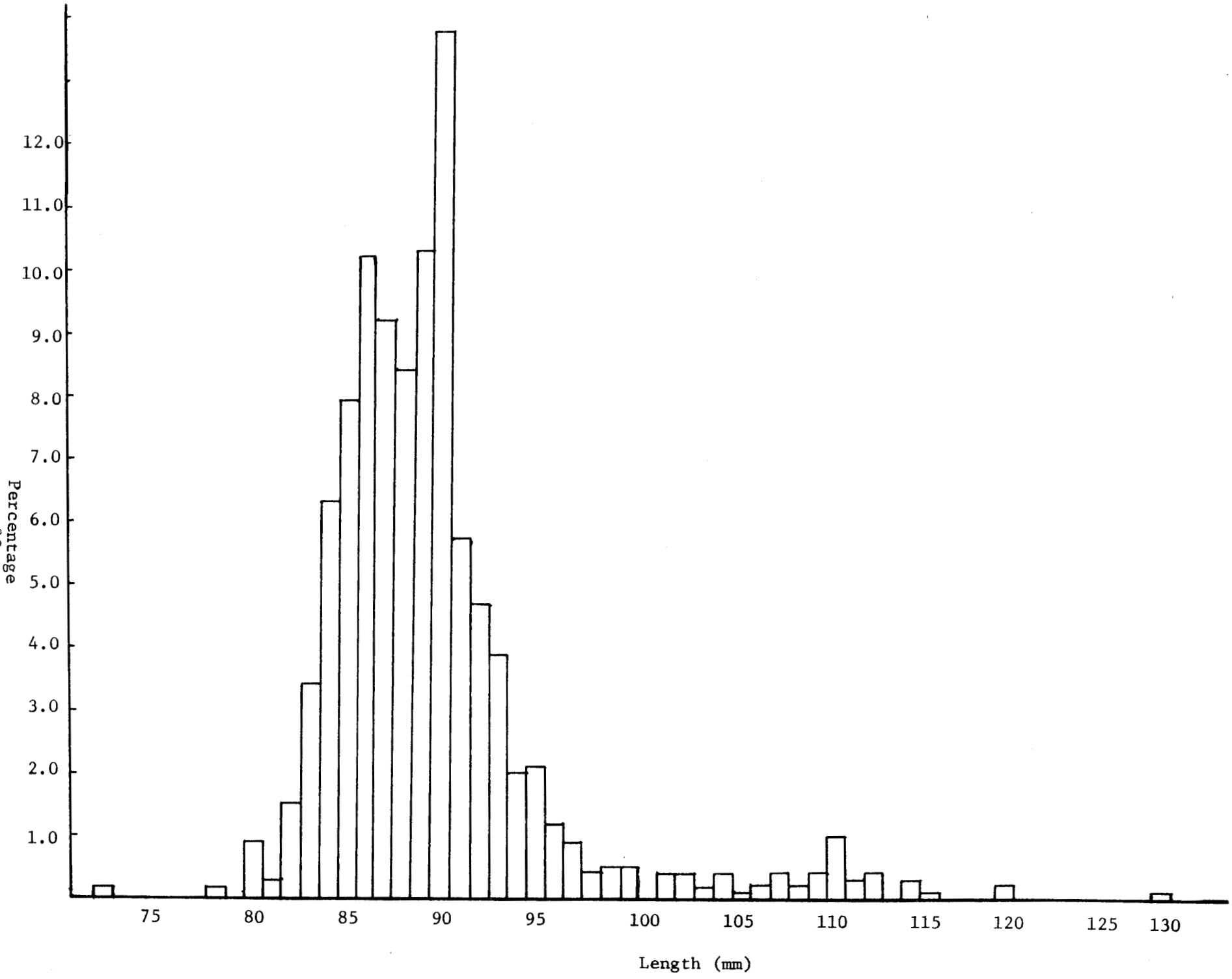


Figure 12. Length frequency summary of sockeye smolt, index site, Kvichak River, June 11-13, 1971

1971 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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INTRODUCTION

This was the sixteenth consecutive year that the Naknek River sockeye salmon smolt study has been conducted. The 1971 study was initiated by Mr. Darwin A. Biwer, Jr., while the continuance and termination of the study was the responsibility of the author. The field crew consisted of Mssrs. Monty Smith and Dave Steinhoff, crewleaders, and Murray Peters and Frederick Hood, crew members.

METHODS AND PROCEDURES

The objective of the Naknek River smolt program is to obtain an outmigration estimate of sockeye salmon smolt and their age composition.

Equipment used to trap smolt during the 1971 season were standard fyke nets, four (4) feet in width and four (4) to seven (7) feet in depth. The nets were fished by suspending them from a cable stretched across the river bottom. The fishing site is located approximately 8-3/4 miles downriver of the Naknek Lake outlet (see Figure 1). To lower smolt mortality, live boxes, attached to the nets, were used throughout the season on both the random and index schedules.

In 1957 and 1958, the entire river width was fished to determine the most productive sites. Six sites in the main channel are now fished. Data obtained from 1957 and 1958 indicated that 88.34 percent of the entire outmigration passed within these sites. The most productive of the six sites is used as an index site (Van Valin, 1969).

The basic fishing schedule used for the Latin Square scheme is three (3) days in length. The first days all six sites are fished in a random order

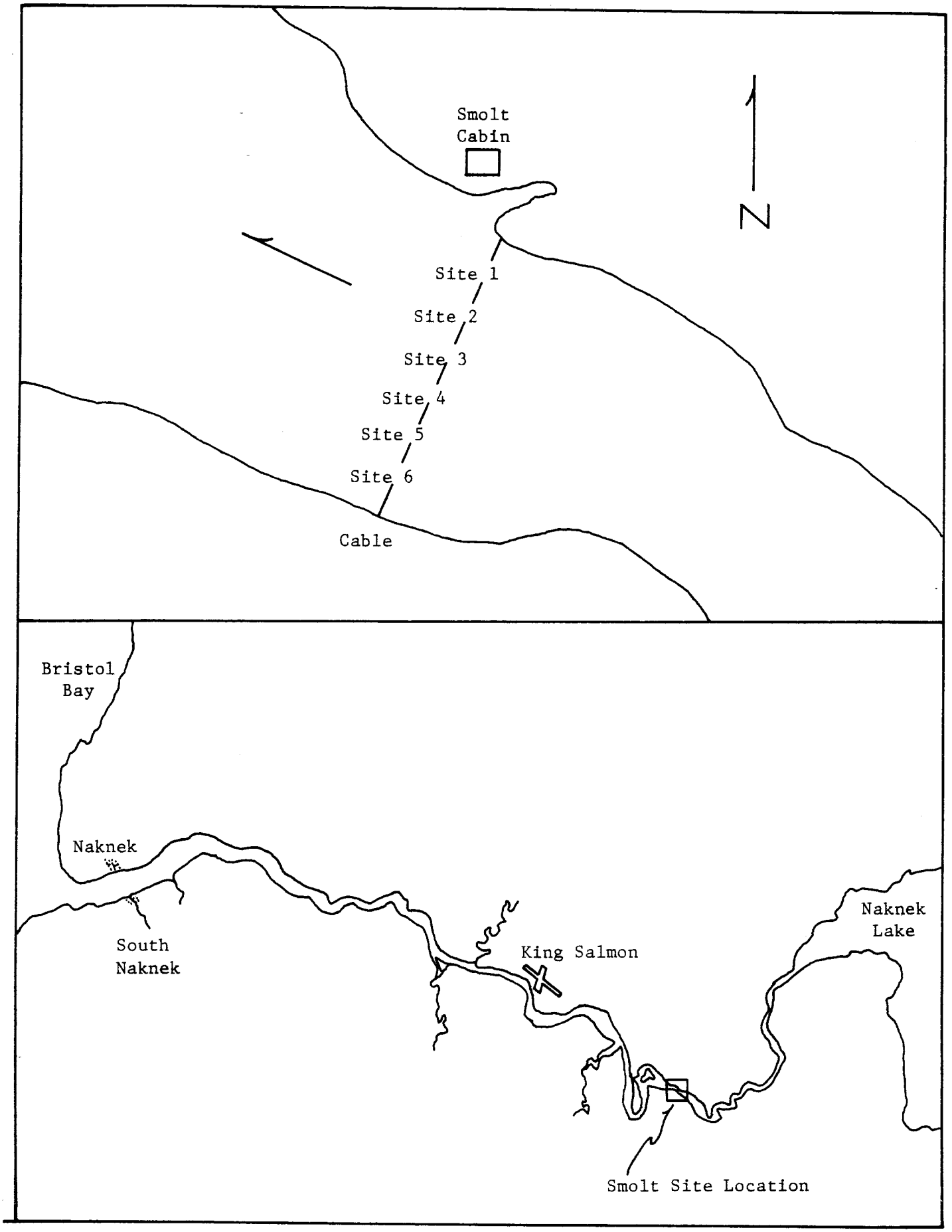

FIGURE 1. Detail of the Naknek River smolting site and the site's location on the Naknek River.

from 2100 hours to 0600 hours. Each site is fished for a 90-minute period. Day two is fished in the same manner, with the addition of the index site (site 4, see Figure 1), which is fished for 24 hours or from 2100 hours to 2100 hours. During the next 24 hours, day 3, no fishing is conducted. Random fishing schedules are set up previous to the season. In this manner, a random sample of numbers of smolt is collected. This data is then expanded to obtain a total outmigration estimate, using the Latin Square method.

Sampling for age-weight-length data was conducted as in previous years. The procedure is to collect twenty (20) samples previous to 2400 hours and twenty samples after 2400 hours. In order to insure that all fishing sites are sampled throughout the season, ten (10) samples are collected from the site fished from 2100-2230 hours, and ten (10) samples are collected from the site fished from 2230-2400 hours. The following samples are collected in the same manner, with the sampling times being 0000-0130 hours and 0130-0300 hours.

RESULTS

Table 1 contains all mean water and air temperature data gathered during the smolting season. The peak of migration was observed during June 13-14.

The 1971 outmigration was estimated to be 10,864,064 smolt, approximately 200,000 fish above the sixteen year project average as shown in Table 2. Age composition of the outmigration was determined to be 8,036,148 (73.97 percent) Age I smolt and 2,827,916 (26.03 percent) Age II smolt for a total outmigration estimate of 10,864,064. No Age III smolt were caught during the 1971 season.

Table 3 gives the migratory age distribution. Average weights for Age I and Age II smolts were 8.8 and 13.5 grams respectively. Average lengths for Age I and Age II smolts were 102 and 120 millimeters respectively.

TABLE 1. Mean water temperature by day, Naknek River, 1971[1/]

Date	Mean Water Temperature °F	Mean Air Temperature °F
June 6-7	43°	46°
7-8	41°	44°
9-10	40°	46°
10-11	42°	48°
12-13	42°	45°
13-14	44°	46°
15-16	42°	41°
16-17	42°	43°
18-19	41°	45°
19-20	*	52°
21-22	44°	60°
22-23	46°	65°
24-25	47°	58°
25-26	47°	51°
27-28	47°	44°
28-29	*	41°
30-7/1	48°	43°
July 1-2	49°	53°
3-4	*	55°
4-5	*	56°
6-7	50°	59°

1/ Water temperatures were recorded six times daily

* No temperatures recorded

TABLE 2. Sockeye salmon smolt migrations, Naknek River, 1956 - 1971.

Year of seaward migration	Number of Age I	II	III	Total
1956	5,064,000	936,000	-	6,000,000
1957	1,760,401	1,280,015	-	3,040,416
1958	9,698,033	362,167	-	10,060,200
1959	10,034,717	2,430,770	-	12,465,487
1960	3,553,121	3,118,182	20,074	6,691,377
1961	4,366,639	1,246,008	-	5,612,647
1962	8,000,637	8,461,579	-	16,462,216
1963	6,049,747	8,717,000	134,108	14,900,855
1964	2,248,013	4,973,098	7,228	7,228,339
1965	14,741,194	9,878,527	88,951	24,708,672
1966	3,114,885	6,098,025	-	9,212,910
1967	4,096,836	5,284,965	25,399	9,407,200
1968	7,661,568	10,543,954	390,517	18,596,039
1969	6,907,982	4,638,035	-	11,546,017
1970	2,018,207	1,634,657	-	3,652,864
1971	8,117,574	2,856,570	-	10,974,144
Average	6,089,597	4,528,722	41,642	10,659,961

TABLE 3. Naknek River sockeye salmon smolt, migratory age distribution, 1971

Date	Age I Percent of total season's catch	Age II Percent of total season's catch
June 6-7	0.48	1.99
7-8	1.05	11.67
9-10	1.85	24.11
10-11	0.55	10.67
12-13	12.37	16.48
13-14	35.61	10.94
15-16	2.43	2.24
16-17	9.07	2.04
18-19	5.49	5.76
19-20	3.65	4.33
21-22	2.66	0.39
22-23	2.67	0.82
24-25	4.43	5.26
25-26	3.57	0.52
27-28	4.59	0.67
28-29	3.50	1.08
30-7/1	4.18	0.61
July 1-2	0.17	0.17
3-4	1.25	0.18
4-5	0.06	0.01
6-7	0.37	0.06
	100.00	100.00